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ORIGINAL

STRATEGY AND PLAN FOR A NATIONWIDE TECHNOLOGY TRANSFER NETWORK TO ENHANCE PRIVATE AND NONFEDERAL USE OF NEWLY DEVELOPED TECHNOLOGY FROM NASA AND OTHER SOURCES

Volume 1: The Strategic Setting

Prepared by:

Paul R. Brockman

Submitted to:

Technology Utilization Division
Office of Commercial Programs
National Aeronautics and Space Administration

Submitted by:

LFW Management Associates, Inc.
P.O. Box 12325
Arlington, Virginia 22209-8328

June 30, 1986

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VOLUME 1

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FOREWORD

It is both reassuring and heartening to witness the progress and expansion of NASA's Technology Utilization Program (TUP) since its inception in 1962. Technology utilization (known as "industrial applications" in the early days) was an initiative promoted under the dynamic and visionary leadership of the Honorable James E. Webb, NASA's second Administrator. It was an inspiration and rare privilege to have served under his stewardship and to have the opportunity to develop the early program concepts and methodologies. It was Jim Webb's firm conviction that TUP was a goal worthy of NASA's effort and resources and the present-day status of the program where it is now being pursued by almost every major Federal R&D agency confirms his early prediction.

As one would surmise, it was particularly difficult in the early 1960s to get the scientists and engineers bent on landing a man on the moon by the end of the decade to turn their thoughts to practical applications of space technology here on earth. Nevertheless, with a handful of broadly-oriented, far-sighted professionals and the strong endorsement and support of top level management, NASA was able to firmly establish its Technology Utilization Program.

This newest initiative of the Technology Utilization Division, in NASA's Office of Commercial Programs, to develop the strategy and plan for a nationwide technology transfer network with the help and cooperation of the other Federal agencies organized under the Federal Laboratory Consortium (FLC) should make a major contribution to our nation's international industrial competitiveness and GNP. An essential element in the plan is the strengthening and expansion of working relationships with the states' economic and technology assistance organizations to assure not only their full participation in the nationwide network, but also the realization of its benefits. These state-sponsored programs provide avenues for reaching industry which were not available until this decade, and which fill major gaps in the formation of the nationwide network.

LOUIS B. C. FONG
President, LFW Management Associates, Inc.
(NASA's First Director, Technology Utilization Program, 1962)

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PREFACE

This report lays policy and management foundations for negotiating and/or renegotiating agreements and otherwise developing constructive, mutually useful working relationships between the NASA Technology Utilization Program and other technology transfer (T^2) programs in the development of a nationwide T^2 network. It focuses primarily on linking NASA's Industrial Applications Centers (IACs) and the growing state-sponsored programs to apply advancing technology to industrial development as the most expeditious means of building that network at this time. However, it also addresses other opportunities, including IAC access to Federal Laboratory Consortium members, and new avenues for addressing the operational technology needs of state and local governments. In one dimension it addresses opportunities to improve the flow between "upstream" technology resources and "downstream" technology users. In another dimension it addresses the facilitation of linkages among intermediaries in that flow.

It has been developed with reliance on a wide range of information resources, including:

- Published information on the relevant state, NASA and other Federal activities, including existing and proposed legislation;
- Interviews with the majority of the key state-level leaders overseeing specific state programs;
- Interviews with NASA program leaders and participants, including all IAC directors and other NASA TU contractors;

- Interviews with selected representatives of other Federal technology transfer programs, especially those with experience with the state initiatives; and
- The pre-existing personal knowledge of the topic on the part of the author and his professional associates.

Volume 1 addresses the strategic setting within which the opportunities for cooperation in transfer exist. Volume 2 proposes specific strategies and plans for NASA's use in effecting that cooperation.

This report is submitted in fulfillment of the requirements of Contract NASW-4128, funded by the Technology Utilization Division, Office of Commercial Programs, NASA Headquarters.

The author expresses his appreciation to Louis B. C. Fong, President of LFW Management Associates, Inc., for his untiring efforts in support of this project, including a number of thoughtful contributions in the framing and editing of the report.

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STRATEGY AND PLAN FOR A NATIONWIDE TECHNOLOGY

TRANSFER NETWORK

Volume 1: The Strategic Setting

EXECUTIVE SUMMARY

I BACKGROUND

The Technology Utilization Division, Office of Commercial Programs, NASA Headquarters, determined that it is timely to explore the possibility of establishing a nationwide technology transfer network that would encompass not only NASA field centers and its Technology Utilization Program (TUP) elements (i.e., IAC's, Applications Teams, etc.), but also other Federal agencies' laboratories (i.e., members of the Federal Laboratory Consortium (FLC)), state-sponsored technology assistance centers, and certain members of the academic community and the private sector. Such a network would not only accelerate the transfer of newly-developed technology and insure early and improved access to new technology by those participants who have need for new technology, but also contribute to the international industrial competitiveness of the U.S.

II STRATEGY AND PLAN FOR A NATIONWIDE TECHNOLOGY TRANSFER NETWORK

The first phase of this study and analysis was to develop a strategy and a plan for a Nationwide Technology Transfer Network. Initially, it was necessary to investigate what opportunities for cooperation in transfer existed or could be developed. Thus a wide range of sources and resources were explored which included:

- existing and proposed legislation; selected Federal and non-Federal activities;
- key officials in state agencies and state-sponsored university centers;
- key NASA TUP personnel at IACs, field centers, and TU contractors;
- selected representatives of other Federal technology transfer programs, i.e., members of the FLC.

Primary attention was given to linking the Federal and state-sponsored programs.

Technology transfer has matured to the stage where it has gained Congressional support through legislative laws and acts (PL 96-480, the Stevenson-Wydler Act of 1980, and its proposed major amendments) and has become a nationally recognized objective of major Federal programs. During the past five years, the states have individually sponsored, with their own resources, technology transfer and technology applications initiatives surpassing in the aggregate any prior commitments in this challenging area.

A. <u>State Sponsored Technology Activities</u>

Political and economic trends in recent years have given the states the impetus to adopt programs and funding initiatives to help strengthen the technological base of their industries. Each state has, however, developed its own unique policy, institutional structure and programs, although there is commonality in their goals, namely, economic development and technology innovation, including technology transfer.

States have actively pursued cooperative university/industry arrangements to insure research and development on technology focused on the states' industries' needs and interest. These arrangements are sometimes designated "centers of excellence" and "engineering research centers." These centers also provide an excellent opportunity and avenue for the promotion of rapid commercialization of technologies emerging from Federal laboratories and agencies.

The most relevant elements for networking with Federal technology transfer activities in the array of state programs are the business and technical assistance centers. These vary widely in organization, location, and manning, but at best seek to draw together business and market planning and analysis, venture evaluation, financing and technology assistance to support industrial innovation and entrepreneurship. Many of these include newly-formed incubators which, as the term implies, perform the role of supporting and nurturing new businesses by providing technological assistance, resources and facilities. Where an incubator exists in cooperation with a technical assistance effort to non-residents, the term "innovation center" is likely to be used.

Research or industrial parks are potential elements of the network, as a special category of technical assistance centers. The goal of these parks is to ensure long-term industrial growth and stability through the media of advanced technology, by providing attractive long-term sites for advanced technology industries.

Since economic development and technology innovation can be promoted through programs which provide improved education and training, states have placed greater emphasis on math and science, expanded opportunities for worker retraining, and new vocational education offerings to match emerging new technologies.

B. Federal Programs in Technology Transfer

Early programs in technology transfer were rather narrowly focused on the primary mission of the agency, and pursued initially by the U.S. Department of Agriculture in its Agricultural Extension Service and later, by the National Advisory Committee on Aeronautics (NACA) and the National Bureau of Standards. It was not until 1962 that NASA under its then unique charter undertook secondary transfer of technology on a much broader basis. Other agency programs followed.

The Stevenson-Wydler Act, P.L. 96-480 of 1980, is recognized as a milestone in promoting widespread use of Federally sponsored technology as a national policy, with certain security restrictions. It is now being amended in ways which are expected to extend its provisions to all Federal technology producing entities, whether or not these are categorized as R&D activities, and to provide a clearer base of authority for the FLC. The result should be a firmer base of Federal technology resources for transfer purposes, and a clearer mandate for transfer.

C. Science and Technology for the Non-Federal Public Sector

Organized technological assistance to towns and smaller cities is most actively pursued in two states, namely, Oklahoma and Kentucky. Public Technology, Inc. (PTI) which serviced both states and local government in the early 1970s, has been restructured so that it now services primarily urban counties and the larger cities with more than 100,000 population. For most of the nation, a void exists in technology assistance for the towns and small cities.

The two states mentioned above provide unique avenues for improving locally-oriented technology assistance programs. The major problem faced by these groups is their funding, which is primarily reliant on the legislatures of Oklahoma and Kentucky. These two groups, together with four new state innovation groups, in formation, and others which may soon be formed could provide good outreach resources for the NASA TU Program and the FLC.

The Council of State Governments (CSG) headquartered in Lexington, Kentucky, offers to the Federal agencies and industry, the most promising source for the future aggregation of state technology needs. The CSG has already established research centers focused on particular areas of concern to the states. CSG has a working relationship with NASA/University of Kentucky Technology Applications Program (NASA/UK TAP) and a formal agreement of these two organizations with NASA is being negotiated.

D. Key Policy Considerations in Forming Federal-State and Federal Interagency Linkages

The development of network relationships for technology transfer involving Federal, state, local, and private entities requires sensitivity to a number of policy considerations. The most significant of these, in our view, are:

- relationships which already exist,
- individual state needs and preferences,
- the relative absence of interstate cooperation on industrially-oriented programs,
- the semi-autonomous state of universities,
- turf,
- the views and interests of the U.S. Congress and its Members,
- the need for a sense of timing,
- the cost of services and especially front-end capitalization,
- the need for direct Federal-industry relations in certain areas, and
- questions of national security and international economic competition.

The strategy proposed in the report seeks to reflect a proper concern for these considerations.

E. Strategy for Federal-State Cooperation in Technology Transfer

1. General

This study and analysis assumes that the foundation of effective technology transfer is to extend effective opportunities for access to as much new technology to as many potential responsive users as is possible and practicable. Successful technology transfer networking depends in the main on a strong user-orientation in the transfer system based upon NASA's experience of the past twenty years, the more recent experience of the most effective state programs, and the experience of some other Federal programs, including Navy's.

2. Specific Recommendations

a. Technology for Industry

The present day institutional setting for technology transfer activities is dynamic, diverse, proliferating, and quantitatively and qualitatively uneven. Thus, any strategy for building a nationwide network for technology transfer should build on the strengths and qualities of existing organizations, and develop relationships among them so that the participants can draw on each others' strengths.

About 35 of the states offer the most ready opportunities for networking in the areas of technology, technical services and technical information. An additional ten more could move in this direction in the near future, provided they are approached with diplomacy and tactful consideration.

Another important area in support of networking is the continuation and further development of the IAC-FLC referral system.

The involvement of the several Federal agencies and on-going programs in a transfer network should be continued and expanded. Some linkages between agencies already exist, but need to be strengthened and possibly restructured.

Existing state technical assistance resources offer these advantages:

1) proximity to a far greater proportion of those segments of U.S.-industry which can use new technology for new economic activity;

2) a multiplier effect in financial and human resources for direct industry contact, for problem-solving and other "engineering-related services;"

3) a wider, more stable base of concern for Federal technology transfer program continuity;

4) new, current, almost free sources of "intelligence" on technology needs of U.S. industry, as candidates for the application of Federally developed technology.

b. Technology for the Public Sector

Ways undoubtedly can, and should, be found to achieve the interchange of information and other forms of non-financial assistance among the several programs and organizations now concerned for public sector technology advances. These include:

- NASA/UK TAP,
- Oklahoma's local government assistance program,
- Penn TAP, the Illinois Resource Network, and other similar programs,
- CSG's research programs,
- PTI,

- FLC,
- the other NASA IACs and Applications Teams.

c. Technology Transfer for Mission Enhancement

The longer-term state efforts to develop their technology bases through university-industry advanced research and development can provide a base of technology activities on which at least some Federal development programs may be able to capitalize. Technology transfer linkages can provide an avenue for bringing together the leaders of these Federal and state-backed programs for the possible development of new cooperative programs.

In dealing with the states, it is important to stress the need for flexibility and understanding to achieve the nationwide capability for technology transfer. To build the network linkages will require discussion, education, mutual acquaintance and respect, the development of communication channels and protocols, and multilateral resource commitments. The scope of the state programs, taken together, and the resource levels and political commitments underlying them indicate that the undertaking should be justified.

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INTRODUCTION

For approximately 20 years, NASA's TU/Dissemination activities were conducted as experimental efforts: to establish whether or not such activities could effectively transfer NASA-developed technology to non-aerospace industrial or public sector uses. At the time these efforts were started, in the early 1960's, there was little if any experience available anywhere in U.S. society to guide these activities. Reliance for statutory authority initially was placed on the studies of benefits clause of the "Space Act", and on that Act's requirement for geopolitical balance. As the early studies demonstrated techniques that actually proved to be effective in disseminating technology, the TU program began to rely on the "widespread dissemination" clause of that Act.

The experimental approach was both appropriate and necessary. In the first place, no one had specific expectations of what, exactly, would result. Further, there was no direct competition, and there were no alternatives.

The times have changed: dramatically so, in both the public and private sectors.

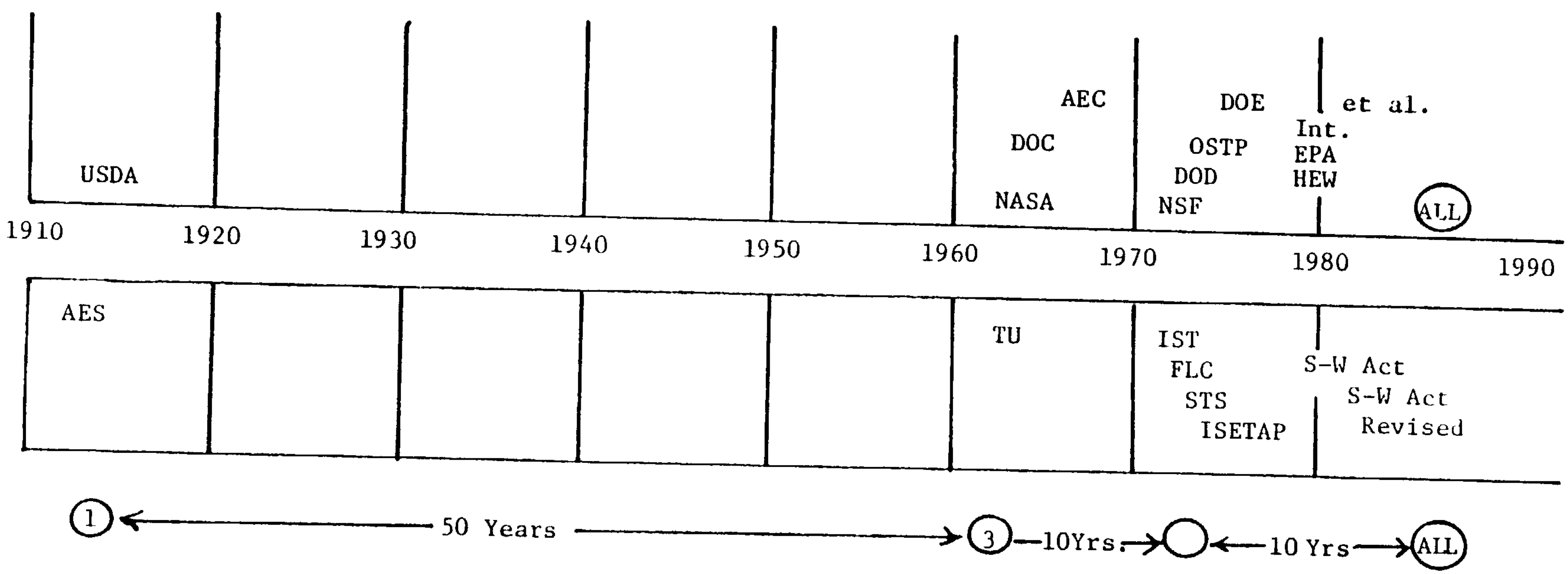
To begin with, other Federal agencies, both independently and cooperatively, entered the field, with the result that the Federal Laboratory Consortium and other organized activities now exist to transfer Federally-developed technology to industry. Through these activities, the sheer numbers of individuals involved have been multiplied several fold in the past decade. These efforts have gained sufficient momentum, and broadly based political support, to bring about both the enactment of PL 96-480, the Stevenson-Wydler Act, in 1980, and the anticipated enactment of major amendments to that Act in the current Congress. The Congressional deliberations on provisions for general applicability to all Federal T2 programs, in 1980, and again in 1985-86, have included consideration of measures which almost did (in 1980) and still could (in 1986) require major modifications in the organization and management of NASA's TU program. The growth of Federal programs is charted in Figure 1.

Second, and perhaps most important, international industrial competitiveness in an era of world markets and rapid (and still accelerating) rates of technological change is an issue underlying major public policy decisions on a continuing basis in all governmental sectors within the U.S.. The twin purposes of technological advance and its rapid application to economic and industrial strength are politically powerful rationales for a wide range of Federal, state, and local government program and activities. One consequence of this has been the development of a far more sophisticated set of policy advisors on economic/technological issues in national and state circles than has ever existed in our nation's past. It is no longer enough to claim relevance to international competitive issues to gain support: policy-making evaluations extend to

FIGURE 1

INITIATION OF TECHNOLOGY TRANSFER/UTILIZATION PROGRAMS

BY FEDERAL AGENCIES



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December 1985
Revised May 1986

pre-consideration of effectiveness tradeoffs. In this climate, where leading politicians and their key professional advisors agree, especially at the state level, support on key organizational and funding votes tend to be virtually unanimous.

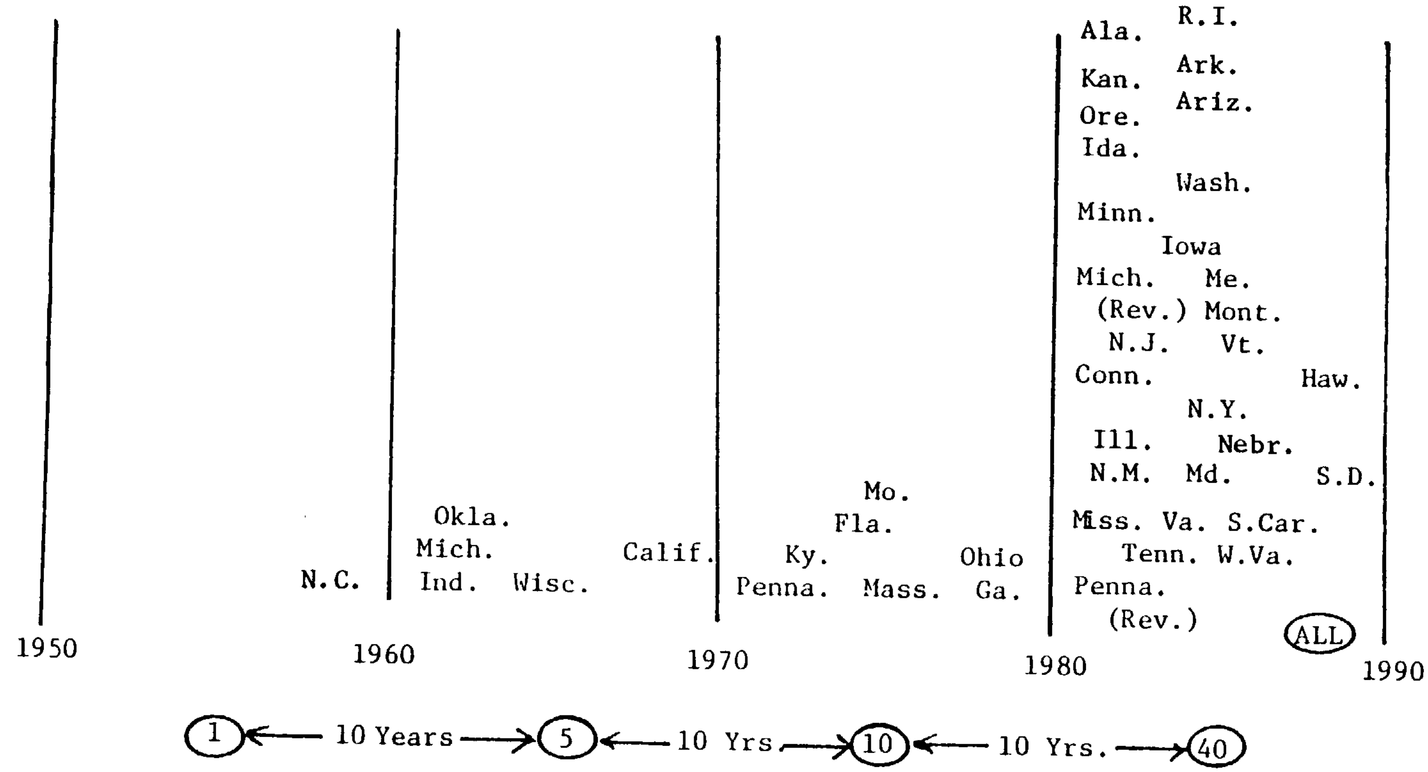
Fueled by these policy concerns, with their eyes kept clearly focused on job creation and retention and on the expansion of their tax base, within the past five years the states individually have established (or revised and expanded in a few cases) what collectively amounts to <u>the largest infusion in such a short time of new resources for technology transfer and new industrial technological applications in human history</u>. A sizeable part of the states' commitment supports industrially-relevant R&D at research universities and institutes or is used to leverage other industry-university R&D cooperation -- preliminary to technology transfer. However, that commitment is transfer or applications-oriented, and is at least equaled in most cases by other programs to put new technology (wherever originated) to work in the marketplace. In many of the states, the assistance goes far beyond technology support and transfer to include management, business marketing, and financial assistance to fledgling technology ventures. Figure 2 portrays the growth of these programs. Many of the state efforts are described in the new <u>Directory of Federal and State Business Assistance</u>, published in May 1986 by NTIS.

While these proliferations of technology transfer organizations, funding, personnel and programs have been taking place, the technology of information processing has been revolutionized to a degree also unprecedented in human history. Bruce Merrifield,

FIGURE 2

INITIATION OF STATE POLICY-DRIVEN PROGRAMS IN

SCIENCE & TECHNOLOGY ASSISTANCE FOR ECONOMIC DEVELOPMENT



Compares with Graham Molitor's Curves for Development and Adoption of Socio-Political Innovations in the U.S.

(Dates for each state are approximate.)

LFW Management Associates/PRB
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the Acting Under Secretary of Commerce for Economic Affairs, has characterized what has happened in this time frame--the past 10 to 15 years--as equally or more significant on a continuing basis than the invention of the printing press. Microcomputers, laser-videodiscs, satellite communications, fibre-optics, advances in electronics signal processing and in materials for the storage, conveyance, and insulation of electronic "messages"--to name but a few--are overrunning the realm of information science and technology.

For various reasons, stemming from all of the above factors, and from the industrial needs existing as our society steps out into the second industrial/information revolution, a commercial industry has emerged as a major provider of routine technical database searches. While it primarily services productivity-enhancement, rather than the generation of new-economic-activity, it has taken over a sizeable portion of the pre-existing latent market for the types of services initially provided by the routine search components of those T2 programs begun in the 1960s. It participates in a national association headquartered within four blocks of the U.S. Capitol building, which also includes data and communication equipment suppliers, among others.

Over the past 20 years, the pendulum of national policy has swung both left and right on the question of where the responsibility lies, and to what degree, for what kinds of economic stimulation. The 1960s were years of heavy Federal involvement in economic development, as well as in the building of the "Great Society." The advancement of science and technology was a clear Federal mandate, largely channelled through NSF, NASA, and DOD. Yet, the old concern for traditional physical infrastructure -- bricks, mortar, rail spurs and highways -- dominated policy considerations in economic development. The later years of that decade and the early 1970s, however, saw an increase in concern for technological assistance, its possibilities symbolized by the Apollo lunar missions, and its potential fueled by thousands of engineers laid off in the Apollo and Vietnam phase-downs. Tax policy would support the traditional physical infrastructure focus for economic development throughout the 1970s. However, the overload on existing avenues for delivery of Federal services resulting from the programs of the 1960s, led to a greater need, role for, and emphasis on, state and private sector leadership.

While several Federal programs specifically for economic development still exist, the trend in recent years has been toward removing or abolishing the leadership role for "Uncle Sam" which developed in the 1960s. The Federal regional commissions, except for the Appalachian Regional Commission, have been abolished. The Economic Development Administration is a shell of its former self, its University Centers Program, which helped give rise to several of the states' current programs, one of its few, low-level survivors. The Small Business Administration (SBA) has survived Presidential opposition and presents an anomaly. SBA's Small Business Development Centers

(SBDCs) offer another set of Federal-State linkages. Most of the balance of recent Federal concern for economic development is focused around science and technology: NSF's growing set of engineering research programs and its concern for cooperation with the states' initiatives, OSTP's recently issued "National Aeronautical R and D Policy", NASA's emphasis on the commercialization of space and of aerospace technology, and the growing political popularity of Federal laboratory-industry activities (i.e., the Federal Laboratories Consortium). Given the issue of the international competitiveness of U.S. industry, support for a strong Federal role is not dead -- but now focuses primarily on issues of technological and human resource capabilities. Much of the residual emphasis is on developing the shortest, most direct and most efficient lines from the performers of Federally sponsored R&D to U.S. industrial users, and on worker training or retraining issues. The Spring 1986 Meeting of the Federal Laboratory Consortium (FLC) which addressed the theme of networking was a significant landmark in this regard. It was reported by veteran observers and participants to be the first such conference that focused on laboratory-user/client transfer methods, rather than on the setting of the transfer function within the laboratories themselves.

With the new environment allowing and stressing leadership and autonomy for the states and for the private sector, a shift to those sectors has taken place in matters of technology for state and local government agencies. OSTP has abandoned the field, and NSF's Intergovernmental Science and Technology program is dead. Public Technology, Inc., has survived the transition to emerge as a user-based, rather than technology-source-based intermediary. In this arena, NASA has fared well, primarily because its public sector technology applications have been driven by user-identified requirements and implemented by private industrial and commercial suppliers. However, a wide range of public sector technology needs assessment activities are institutionalized in state and local governments and in the national associations of their operating officials, and most Federal agencies have yet to develop any regular pattern of communication with these activities beyond those which relate to the agencies' direct missions.

Given the above seven external dimensions of the general context in which Federal T^2 programs operate, it seems advisable that these programs continue to rethink their roles and participants, as well as the way in which the old ones are arranged or rearranged. The funding of the contract under which this report has been developed and the preliminary steps that program management has taken during the past six months are evidence of the NASA program leaders' willingness to move in the direction of more extensive networking.

In the following pages, these seven dimensions are taken up in greater detail, not only for the sake of identifying the networking opportunities, but with a view to highlighting those that appear at this point in time to have the highest priority in terms of readiness and capacity. "At this point in time" is a caveat that cannot be stressed too much. The landscape is dynamic and growing. The states, especially, are moving rather rapidly to strengthen weak spots and fill gaps. The challenge is for Federal agencies and officials to be aware of these changes, and to use that awareness to guide their programs and institutions into their proper roles in a nationwide network aimed at sustaining and strengthening the competitive performance of U.S. industry. This report addresses that challenge as its principal objective.

CHAPTER I

TECHNOLOGY FOR INDUSTRY--THE STATES TAKE THE INITIATIVE

The majority of states have adopted programs to help strengthen the technological base of their industries. In doing so, they have looked to each other and to older, nationally-suggested programs for ideas and models -- and yet each has developed its own unique policy, institutional structure and program. Each new nationwide survey report of these state activities, beginning with the one published for the National Governors' Association (NGA) in February 1982 and continuing through the studies by Charles Watkins, which NGA published in February 1986, has come up with a new or varied outline (or taxonomy) of the state programs. Each taxonomy has been designed to relate the programs to the policy aims of the study that it supported. Only Watkins' studies approach adequacy from the standpoint of the present study, and that perhaps because Watkins was more concerned with technology transfer in its broadest dimension than were the earlier reports. The nature of our assignment for NASA under the present contract has led us to build our own outline of these programs, an outline that draws on, but restructures, Watkins' classification (see Figure 3).

Subscribing to Rufus Miles' "First Law of Administration", the rule of perspective that "where you stand depends on where you sit," the reader should keep clearly in mind that this

FIGURE 3

KINDS OF STATE PROGRAMS

Watkins' Taxonomy	Taxonomy for Transfer Linkages
Policy Development	Policy Development
Education and Training	*Research and Development
Research and Development	Financial Assistance
Entrepreneurship Training and Assistance	**Entrepreneurship Training and Assistance; Business and Technical Assistance; Technology and Information Transfer; Incubators
Financial Assistance to Innovating Firms	
Technology and Information Transfer	
Research or High-Tech Industrial Parks and Incubators	Research or High Tech Industrial Parks Education and Training

NOTES:
*Long-term opportunities
**Short-term opportunities

classification of the state programs is solely for the purpose of facilitating technology transfer linkage opportunities. Therefore, in 4, below, we have packaged together those types of programs that provide for direct interfaces with multiple clients, at the clients' initiative, and that provide direct assistance to specific client entrepreneurs or firms on their particular questions or needs.

Before discussing these state initiatives in any detail, several notes of caution need to be sounded. SINCE EACH STATE IS UNIQUE, ITS PROGRAM WILL TEND TO REFLECT THAT UNIQUENESS. THUS, THE SAME PROGRAM TERM OR TITLE USED IN VARIOUS STATES CAN BE EXPECTED TO DESCRIBE VARYING PROGRAM CONTENT. A "technical assistance center" may or may not have a technological component to offer its client. "Technical" in this usage may mean specialized expertise in management and financial matters. "Seed money" is equally ambiguous. Some states provide "seed grants" to university-based industry-oriented projects in order to stimulate advanced development toward commercial utility. Other states provide, directly with state funds or indirectly through tax incentives, seed capital funds for very early, high risk development not yet mature enough to attract traditional venture capital. THE OPERATIONAL MESSAGE FOR NETWORK DEVELOPMENT EFFORTS IS THAT EACH PROGRAM AND INSTITUTION MUST BE EXAMINED FOR ITS PARTICULAR AND SPECIFIC CHARACTERISTICS AND CONTENT BEFORE ANY JUDGMENT CAN BE MADE AS TO ITS USEFULNESS AS A TECHNOLOGY TRANSFER PARTNER. Thus, when we observe that, as a class, management and technical assistance centers pose opportunities for transfer networking, we are not saying that each and every such center does so.

1. Policy Development

One would be remiss in discussing Federal-state relationships by failing to draw attention at the outset to the groups that most states have established to guide the shaping of their "S&T for economic development" policies. The forms of organization vary widely, and their combinations of policy and operational roles also differ, from state to state. Yet in every state where such a central group exists, it is organizationally and politically close to the Governor, and the group or its staff office has a major voice in establishing priorities, in framing industry-university (and state-Federal) linkages, and (in several cases) in the administration of the state programs. These groups are essential partners in the framing of cooperative relationships with other state-funded programs, as well as for the clarification of state policy on the roles and missions of those other programs. In states that do not have a central policy development group of this type, a senior-level state official may be designated to take the lead in policy development and implementation, and in program coordination. In states that have the groups, the administrators of those groups, or other senior executives in the states' Executive Branches, may have control roles and authorities over and beyond those of the policy groups they support. Appendix A is a list of each state official, as of May 1986. The titles of these officials reflect the diversity of organizational arrangements among the states.

2. Research and Development Cooperative R&D/Technology Development/Centers of Excellence

The most costly, labor intensive and long-term-payoff form of state support is focused through cooperative industry/university arrangements to conduct research and develop technology in areas of industry need or interest -- using the state's universities as a (or the) principal technical resource. Some of these efforts -- as in California and Kansas -- rely on university or professorial initiatives in connecting the universities with particular firms to develop project proposals. In others -- as in New Jersey and New Mexico -- state support is provided primarily to centers that will serve the interests of multiple firms in industry/technology fields identified through statewide assessments of needs and capabilities. Pennsylvania parallels the New Jersey approach, essentially, except that its statewide assessment has been internally regionalized through the four Ben Franklin Partnership Centers. Still other states -- New York and Ohio are examples -- include both the center of excellence and project grant approaches in their strategies. Another set of states -- Maryland, as an example -- has established a general-purpose central "Engineering Research Center" to handle the full range of related matters.

In the specific case of Maryland, the industrial extension service and an incubator are adjuncts to this applied research and development center. Several attempts were made at developing a table or chart to outline these differences. However, the number of significant cross-cutting axes which would have been needed for clarity of description would have produced a confusing visual presentation.

Not only do these centers draw together university, other state government and industry resources, several of them draw added support from Federal programs. The U.S. Air Force is a cosponsor in three of the New Mexico centers, NASA is a cosponsor in a Pennsylvania biological materials center, and the National Science Foundation's Engineering Research Center program has added to its support to state-initiated centers in New York and New Jersey.

In the long-term perspective, these joint industry-state-supported centers and grant programs appear to offer a new opportunity to Federal agencies and laboratories to promote the rapid commercialization of emerging technologies for both Federal mission and technology transfer purposes. The industrial participation pre-establishes the laboratory-to-bench linkage. The state participation, focused on job creation and industrial growth and survival, creates a pressure on the industrial participants to exploit the technology for the benefit of the domestic economy. At this writing, the National Science Foundation is actively seeking through its "NSF Initiatives in the States" project (being conducted for it by

Texas A&M's Center for Strategic Technology), to develop long-term program relationships between the NSF engineering research program and these state programs.

3. Financial Assistance

Leaving direct support of technology development, attention needs to be drawn to the other programs that the states have established for the financing of industrial innovation. Whether through direct appropriations, set asides from pension and other capital reserve funds, or tax incentives for private investments, a number of states have established or induced the formation of funds for "seed" and "venture" financing. Organizationally, the responsibility has been either vested in new financing authorities or corporations, assigned to trustees of capital and fund portfolios, or assigned (or left) to private sector institutions. The types of funding range from equity positions through loans to outright grants -- including as a small part of the total picture in a few states, supplemental grants to recipients of Federal SBIR awards.

The availability of these programs is an essential dimension of the new technology utilization by industry, given several realities of the U.S. economy. Foremost among those realities is the very short-term profitability focus of most large U.S. corporations, driven by investor considerations. Thus, as a key spokesman for the U.S. Department of Commerce puts it in his speeches, "It is the function of small business in America to create jobs, the function of big business to abolish them." That is, industrial product and process innovation, especially that of any high risk, falls to small, start-up entrepreneurially-driven firms. If and when they succeed, larger firms acquire them or their technology, and apply economies of scale. The provision of capital for starting up these high risk ventures is inconsistent with the aims of most of the companies whose stock trades on the major exchanges. Thus, such capitalization falls largely to risk-spreading capital pools, usually put together by financial entrepreneurs. Since capital tends to navigate toward the safest harbors, consistent with profitability, periods of general capital shortage in any economy tend to restrain technological innovation in the marketplace. The late 1970s and early 1980s were such a period of capital shortage, with the result that most states had to serve as the entrepreneurs to stimulate capital for the higher risk (but higher payoff) end of the investment spectrum. Watkins, in his recent reports for NGA mentioned earlier, has highlighted the degree to which venture and high risk capital has been concentrated in relatively few states. What the lasting impact of state-sponsored efforts to disperse that availability will be remains to be seen. However, Connecticut, New York, Pennsylvania, Indiana, Michigan, Missouri, and others have moved boldly to stimulate high risk investments in support of the advanced technological upgrading of their industrial bases. Technology transfer has a better chance of putting down lasting roots where such nourishment is available, as does any form of technological innovation.

4. Technical and Business Assistance

As noted at the start of this chapter, we are packaging a rather wide range of direct business assistance activities in this category. It includes programs and centers variously labelled as entrepreneurship training and assistance; business and technical assistance; technology and information transfer; incubators; industrial extension services; innovation centers; and small business development centers; among others. These programs generally provide for responses to client requests, within the varying ranges of services that are provided. All appear to have some flexibility to adjust or expand that range of services, so that technological assistance can be provided, even where it is not now offered.

These activities have the common feature of helping specific firms address specific management or technical concerns on a relatively immediate, short-term basis. With respect to those services they provide, they are more or less similar to the problem-definition, search, and interpretation functions of NASA's IACs. Like IACs, they may be supported by a sizable consortium of schools. They go beyond IACs generally, in that technology assistance normally is supplemented with management and marketing assistance and/or financial brokerage services. Unlike IACs, search and follow-up assistance may be limited to the resources of the host university (or even a part of it) or other universities within the same state, and may or may not be supplemented by outside data bases. Not only do these programs assist with respect to the direct commercial concerns of their clients, some of these state efforts provide substantial technical and managerial help to entrepreneurs in preparing SBIR proposals and seeking Federal contracts. Some of these have drawn early support from the University Centers Program of the U.S. Department of Commerce's Economic Development Administration, although that support has been sharply curtailed in recent Federal budgets. As a result of having that support, some are restricted in the geographic areas they may serve: thus, they may be sub-state rather than statewide centers, in reality. Many are members of NAMTAC -- the National Association of Management and Technical Assistance Centers. Industrial extension services tend to be assistance centers on wheels or with outlying offices -- echoing something of the agricultural extension model and, in some cases, paralleling it in the university structure.

This set of activities also includes, for our purposes, the SBA-sponsored Small Business Development Centers. Despite the uniformity of their names, the SBDCs deliver varying mixes of services. However, several of them, as in the states of Washington and Missouri and at Arlington, Texas, have technology assistance capacities.

Also included in this classification are the hundreds of newly-formed incubators that provide building space and supporting services for the conduct of business and product development activities. These incubators draw from a variety of sources for their basic support: larger industrial firms, universities, state governments, local governments and/or combinations of these. The presence of significant technological services in support of an incubator generally depends on its ties to a university or non-profit research center. Whatever the setting, the substance of the work that goes on in these incubators is determined by the firms that are admitted to the incubator. Many incubators (there are exceptions) limit support services to the firms that are in residence or have been recently "spun out." Some, however, exist under the auspices of, or adjacent to, management and technical assistance centers or innovation centers, so that they share support functions with outside clients. Either way, they have clients with a potential need for technological assistance, and have established methods of interacting with those clients.

Innovation centers are included in this category since they tend to be enlargements or combinations of incubators and technical assistance centers. Some, however, may include some capability, and the mission assignment, to perform or support research that will be of use to their industrial clientele.

Several universities, partially in response to the concerns of the state governments for industry's technological revitalization, and partially in response to their new roles as owners of the Federally-sponsored intellectual property that they develop, have set up or expanded their own technology transfer offices. A major aim of these offices is to financially exploit the university's patents. Depending on other responsibilities and their setting, these offices may (or may not) have an interest in focusing on industry needs rather than on the marketing of patent licenses.

5. Research or High-Technology Industrial Parks

These activities, of which North Carolina's Research Triangle Park is the oldest, are attempts to replicate by design what happened "naturally" along Route 128 in Massachusetts and in California's Silicon Valley. Their aim is to attract a critical mass of "clean" (usually), advanced technology firms so that long-term industrial stability and/or growth can be promoted.

To the extent that they are successful, they provide nests of clients for technology transfer services. Some have a central service and support core for their residents -- Research Triangle provides one and Arizona State plans to open one in 1987 -- and these core elements are in a position to facilitate technology transfer. In this dimension, the core elements should be viewed as technical assistance centers under 4, above.

6. Education and Training

These programs are directed to a wide range of concerns. At one level, most states are seeking to strengthen basic math and science education in the elementary and secondary schools. Many are also seeking to improve the quality and relevance to emerging technologies of their vocational education offerings, and similarly to expand worker retraining opportunities. In some states, the programs go so far as to provide job-specific training for new or expanding businesses. In the latter case, they become relevant to technology transfer, and will tend to be included in the services that industry can access through management and technical assistance centers.

Chapter II

The Changing Federal Programs and Perspectives

For approximately 50 years, the only widely known Federal technology transfer effort was the U. S. Department of Agriculture's Agricultural Extension Service. In many respects, it was not a national effort, but a collection of state programs, primarily based in Morrill Act land grant colleges, with provision for regional coordination among states with similar agricultural bases. A relative handful of other Federal agencies carried on direct relationships (or vertical transfer), on a national basis, between their laboratories and the industry those laboratories supported: Two notable examples of this were the National Bureau of Standards (NBS) and the National Advisory Committee on Aeronautics (NACA).

Secondary (or horizontal) transfer, however, really seems to have begun with NASA's technology utilization program in 1962. In the past quarter century, the widespread use of Federally sponsored technology has become fixed as a national policy, subject to limitations only for national security and a handful of lesser concerns, discussed in Chapter IV.

In 1980, the next true watershed year, this mandate for widespread use was extended to most Federal R&D activities through the Stevenson-Wydler Act, P.L. 96-480. Now, not quite six years later, a consensus is forming for its extension, to some extent, to other Federal engineering and technology-producing activities -- whether formally labelled as R&D,

or not -- such as some of the military supply depots. Equally significant, the relatively informal, semi-official transfer coordination activities represented by the Federal Laboratory Consortium are being considered for legal recognition as an instrument of national technology transfer policy.

The U. S. House of Representatives has passed H.R. 3773, a bill giving a legislative charter to the FLC, the Senate is expected to pass a similar measure in June or July 1986, and Congressional clearance of a compromise is expected shortly thereafter. The proposed charters are broad enough to give the FLC (or agencies which might gain control or significant influence over it) wide latitude in the structuring of cooperative, interagency, inter-laboratory transfer activities. The present FLC membership includes those who are inclined toward the use of intermediary groups as well as direct contacts and those favoring an emphasis on direct laboratory-user relationships. The FLC national leadership is undertaking to develop working relationships for the FLC with industrial and trade associations and with state economic development programs. The direct value of domestic technology transfer to the nation's well-being, and its secondary or derivative value to the political goodwill toward Federal agencies which engage in it, has not been lost on key officials of a number of Federal Executive agencies.

NASA has separately contracted with the Denver Research Institute for a review of the technology transfer activities of the other Federal agencies. This report therefore reserves recommendations on the incorporation of other Federal agencies' activities beyond the suggestions involving the FLC and the joint EDA/state-sponsored university centers discussed in Chapters I and V.

Chapter III

Science and Technology for State and Local Government Operations

When the NASA and NSF-supported science and technology efforts in behalf of state and local government began, over 15 years ago, and up through the early years of Public Technology, Inc. (PTI), the states were as much a part of the PTI service population as were local governments. By the mid-1970's, however, the key national associations of state leaders had left the PTI board, and PTI was restructured largely as a technology service bureau for local governments.

In the past 10 years, PTI's early principal source of support -- the generators of technology -- has fallen off to a distant third behind the funds it receives from its local clients and companies which translate new technology into products and services. Its clients include most of the cities and urban counties with populations of more than 100,000, and it performs for them both direct individual assistance and intercity market aggregation functions. In addition, it provides guidance to commercial firms in their efforts to develop products and services to meet local government needs.

PTI, however, reaches very few of the smaller cities and towns of the nation. Effectively, its contributions to them flow from any utility which its work for larger jurisdictions may have for smaller units of government, and are limited by the fact that different scales of operation call for differing technologies in many cases.

In terms of technological assistance to the towns and smaller cities of the nation, we have been able to identify two organizations, one in Oklahoma and one in Kentucky, which offer significant services for any sizeable number of clients. Each is, effectively, a single state organization, although opportunities may exist to expand that service area, at least for the one in Kentucky. The Oklahoma Center, based at Oklahoma State University, Stillwater, is a largely state-funded survivor of NSF's former intergovernmental science and technology program. Its location and political base make it a possible candidate for a mutual support relationship of some sort with the NASA-supported Kerr Industrial Applications Center (KIAC) and Rural Enterprise, Inc. (a rural technology applications team), both located in Durant, Oklahoma, as well as with PTI.

The Kentucky program, the NASA/University of Kentucky Technology Applications Program (NASA/UK TAP), provides services to the state government, as well as to the local governments, of Kentucky. Its industrial services are largely derivative from, or secondary to, these state and local services. It is particularly significant as a possible complement to PTI's present focus, since the overwhelming majority of Kentucky's cities are under 100,000 in population -- only Louisville is significantly larger.

All three of these locally-oriented technology assistance programs have one shared problem in serving town and small city clients, and that is the generation of funds to cover the costs. Possible approaches to the resolution of the funding question must be a part of every plan to serve this extensive segment of the American governmental system. It is almost totally reliant on the legislatures of Kentucky and Oklahoma at this time.

An additional approach to meeting the needs of this sector is just beginning to take shape in the form of state innovation groups, drawing heavily on industry support, with encouragement from the Small Business High Technology Institute, and others. NASA's Langley Research Center has entered into the formation of such a group in Virginia. It may prove that these groups can fill at least part of the service vacuum that exists across the country. That possibility warrants monitoring of these groups over the next few years as they develop their service capabilities.

When the state government associations pulled out of PTI a decade ago, it did not put a full stop to efforts to aggregate state needs for technology development. Through most of the 1970's, NASA supported and cooperated with the National Governors' Association, National Conference of State Legislatures, and Council of State Planning Agencies to examine state needs for geo-based data for which space remote sensing could be relevant. That effort, transferred to NOAA along with Landsat satellite operations, has led to a number of sustained innovations in state government relating to natural and physical resources and their monitoring and development.

The Federal Highway Administration has similarly provided for surveys of highway-related technology needs, in cooperation with state highway officials, as a basis for use in the planning of its highway research program.

On their own initiative, the states -- through the association of state information support agencies -- have developed a recurring assessment of state needs for technology related to automated information systems. This group is affiliated with the Council of State Governments (CSG) and headquartered at Lexington, Kentucky.

It is the CSG itself which offers the most encouraging prospect now on the horizon for the future aggregation of state needs. Under its research and state services activities, CSG is establishing research centers to focus on particular areas of state concern. Such centers established in 1985 included agriculture and rural development, management, administration and productivity, environment and natural resources, and financial management. A center on science and technology, generally, is planned for a 1986 start. It is in the aggregation of state needs to formulate research agendas that these centers should, as a by-product, identify needs which can be addressed by new technology as well as those which require new knowledge. The staff of these CSG centers already is being supported in some information searches by the NASA/UK TAP. An Agreement to give formal CSG, NASA, and University of Kentucky recognition to this arrangement is being negotiated. The growth of this relationship, facilitated by the coincidence of the location of both activities in the same city, should contribute to NASA TU participants' knowledge of state needs which could yield to technological resolution, and to greater awareness on the part of state leaders and their national association representatives, of new technological alternatives on policy-related matters. Assuming a continuation and strengthening of the IAC-FLC referral system, this could also facilitate access for multi-state interests to the most relevant Federal laboratories, when appropriate.

Chapter IV

Key Policy Considerations and Caveats in Forming Federal-State and Federal Interagency Linkages

A number of policy issues surround the development of interorganizational linkages among the organizations and programs described in Chapters I, II and III, above. For practical considerations, we are limiting this discussion to those which we see as most significant from a management perspective. All of these policy considerations have a bearing on the strategy suggested in Chapter V.

1. Existing Relationships

The development of new and better relationships is not starting in a void. For example, states have been partners in the NASA-TU program, the Small Business Development Centers, and the EDA University Centers since their inception. The pattern of those relationships has changed over time, and in the case of NASA, the volume has expanded in recent years. The longstanding relationships with North Carolina, Kentucky, Florida, Indiana, and Oklahoma cannot be ignored, nor can they be unilaterally abrogated by NASA without political consequences. Neither, in light of the changes discussed in Chapter I, can this handful of relationships be taken as a major involvement with today's state government efforts nationwide, nor allowed to dominate relations with other states. The same may be said about any agency's relations with any relatively small subset of the 50 states.

2. State Needs and Preferences

Cooperation is not achieved without motivation, and motivation does not emerge in the states based on mandates from Federal officials. The development of specific relationships is a matter for negotiation in which the needs and preferences of each side, the Federal agency and the state or its agency, is openly allowed for. Not only does this make good management sense, it is inherent in the present-day climate of national-state relations, consistent with existing general laws and with the Federalism policies of the Administration. Since not all state capabilities are of equal kind or quality, this flexibility is advantageous to Federal officials from a pragmatic standpoint. Each state is unique in some of the factors that are most relevant to developing relationships for cooperative activities.

3. Absence of Effective Interstate Avenues for Industrially-Oriented State Efforts

There is, at present, no effective opportunity to mount a significant program to move Federally-developed technology to industry in cooperation with any national association of state officials. Those associations do not exist for such operationally-focused purposes. It is useful to involve such organizations as the National Governors' Association, the National Council of State Legislatures, the Council of State Planning Agencies, and the National Association of State Development Agencies in the exchange of information related to national and state programs and plans. They cannot be expected to function as conduits for, or managers of, multi-state projects. The north central states are currently attempting to develop a Midwest Technology Development Institute to serve their shared interests in advancing technology for economic development. The success of this venture remains to be determined. In none of the participating states does it appear to be given the status and importance of other, in-state measures. Science and technology for industry is too closely linked to a state's internal economic health for any state to be willing to cooperate too broadly in situations where its leveraging ability would be diluted. Cooperative Federal-state efforts for industry, therefore, must be expected to focus on linkages between particular Federal activities and particular entities in individual states.

4. Universities as Semi-Autonomous Institutions

Many of the state programs are being carried out through or in cooperation with state-supported universities. These institutions, in most cases, have other avenues of access to Federal decision-making than through their state capitols. The bulk of their state funding is from sources other than those that support the service functions with which we are concerned in this report. They do not necessarily speak or act, in mission and resource-related matters, as pure representatives of their state industry-service interests. Allowance for this is essential.

5. Turf

State interests in bringing S&T resources to bear on industry needs also necessarily involve concern for involving on a priority basis the S&T resources within the state borders: universities, non-profit institutes, and other industrial firms. Furthermore, an institution used by a given state (e.g., a state university) may see its own interests best served by some form of exclusivity as the conveyor of these resources to industry in its territory. On the other hand, Federal agencies have a specific interest in seeing the opportunities presented by their technology applied to the same ends, but without particular regard to the state in which that technology was developed or will be used. The aim of cooperation is to blend these interests in mutually enhancing ways and not to impose one set of concerns on the other unnecessarily. Otherwise, turf issues will get in the way of accomplishment. This, like the issue of state needs and preferences, argues for state-to-state flexibility in Federal-state negotiations.

6. Congressional Views and Interests

It has been said that NASA's technology utilization program is a Congressional, rather than a NASA, program. Several of its existing elements bear the stamp of specific Congressional concern and interests. The same might be said of EDA's remaining programs. The politics of representation of particular state interests by individual U.S. Senators and Representatives, with or without coordination with their Governors and legislatures "back home", continues and will continue. However, events since 1980 should make it clear that the concerns of those few members who have intervened in support of specific programs or agencies are being overrun by a larger Congressional consensus on Federal technology transfer on a general scale, guided by other Senators and Congressmen. These cross cutting interests within Congress merit consideration in the context of state relationships. The opportunities exist for both positive and negative ramifications. The safest policy from the standpoint of widespread acceptance of the professional and technical soundness of program operations is a policy of equanimity and equal opportunity in which particular linkages are developed to meet particular local needs or opportunities under uniform nationwide guidelines that minimize the appearance of the pork barrel and that avoid the entrapment of the Federal Executive Branch in partisan state political hassles. At the same time, election to the Presidency or to Congress carries with it political responsibilities and prerogatives to which agency program managers must attune themselves.

7. Timing

This, some say, is the essence of executive skill. Effective relationships can mature to agreement only when "the time is ripe." In at least one state (Arizona) it appears that 1987 will be that time, insofar as Federal-state industry outreach efforts are concerned, for institutional readiness reasons. In other states (including Missouri, Iowa, Michigan, and New York) state readiness is running ahead of Federal agencies' abilities to evaluate, propose, and negotiate appropriate linkages. Pressures to service (or to neglect) particular states or regions -- for whatever reason -- should not be allowed to override realistic planning for successful linkages under the proper conditions.

8. Cost of Services; Front-End Capitalization

These new relationships will bear front-end costs for both sides. Several of the state S&T leaders who would be involved in developing new transfer linkages with Federal agencies counseled NSF in November 1985, in reference to NSF's engineering programs, that the "early investing states" should not be penalized by Federal subsidization of lagging states. It would appear that Federal agencies need to make their resources equitably available for state cooperation, with due allowance for the duration and extent of parallel state investment. To the extent possible, there should be no "replacement" funds flowing either way. At the same time, past levels of NASA support in particular states should not be viewed as "entitlements," especially if their continuation interferes with the exploitation of new opportunities.

One further caution is in order here, relating back to earlier caveats concerning direct approaches from universities and intervention by individual members of Congress: planning and forethought are needed in order to assure that competition will not be induced with state-backed programs that already are providing comparable products or services, and that complementarity with such programs can be enhanced.

9. Other Federal Technology Transfer Services to Industry

Not all of the Federal technology transfer services are appropriate for delivery through state programs, and not all states have programs through which they can be delivered with state-to-state equivalence. New York and Montana, both "ripe" for linkages with nationwide resources, present extremely different opportunities for Federal officials in terms of size and diversity of the industrial clientele and the organization of state-supported intermediary activities. The proper concern is for networking, not for systems unification. Therefore, continuing direct Federal-industry interaction is to be expected. However, the relationship of related direct services with those to which the state or its agent will be a party needs to be understood at the time of negotiation of each Federal-state cooperation agreement.

10. National Security and International Economic Competitiveness

The Department of Defense has proper concerns that technologies which could affect the military security of the United States and its allies must not fall into the possession of other nations. Thus, the transfer of such technology (wherever it is developed) and in general the transfer of DOD-sponsored technology is subject to scrutiny and controls that can, in some instances inhibit the transfer of technology -- even to U. S. industry. At the same time, DOD actively seeks to involve friendly nations and their industries in the production of weapons and equipment, employing such technology for securing mutual defense agreements. The states, and some other Federal agencies, are concerned for enhancing the competitiveness of portions of U. S. industry in international markets. Thus, they want to see key technologies developed into products or services to be produced and distributed by U. S. industry. They share, if for different reasons, some of DOD's interest in restricting foreign access to the technology. At the same time, at least some of the states are willing to trade away at least some technology controlled by their universities for the sake of access to foreign tech=nology and investment. Allowance for these concerns and interests must be a part of the planning for effective Federal-state cooperation in technology transfer.

Chapter V

A General Strategy for Federal-State Cooperation in Technology Transfer

1. Accessibility and User Assistance - The Key Strategic Elements

Concern for economic growth, international economic competition, the technological and economic revitalization of U.S. industry, and continued leadership in high technology suggests strongly that the technology resource and transfer organizations of the U. S. will serve the national interest well, perhaps best, by developing the nationwide network outlined in the following pages. To do so is, we believe, the most effective strategy for making the wealth of developing technology throughout U.S. government and industry practically accessible to the greatest number of appropriate users.

The components of networking are knowledge, acquaintance, easily used communication links, and inquiry-response protocols. With these in place, need and opportunity will drive the network's usage, and relevance and effectiveness (timeliness, usefulness, efficiency, quality) of results will be the actual measures applied by users.

This study has assumed from the start that efforts to make use of new technology for multiple purposes are, or can be, valuable in both social and economic contexts. Thus, it assumes that technology transfer generally can be and is usually worthwhile. Yet it assumes more fundamentally that the foundation of effective technology transfer is to extend effective opportunities for access to as much new technology as possible to as many potential responsible users as possible. Within limits of human, economic, military, environmental, social and political realities, an effective technology transfer system will attempt to offer all things to all persons.

Such a user-access orientation was not, historically, the basis of early Federal involvement in technology transfer. The Agricultural Extension Service, NASA's Technology Utilization Program, the Federal Laboratory Consortium for Technology Transfer -- all were established to disseminate technology and related information flowing from Federal involvements in research and development to selected audiences. Each developed its own, independent system for reaching its intended audiences, nationwide, with its technology.

Experiences with those audiences over the last twenty years, at least, has established that users and producers of technology do not make up neatly definable subgroups within the economy. As an example of what has happened, the NASA Industrial Applications Centers, required to charge users to cover at least part of the costs for their services, started searching non-NASA technology sources to meet client requests when NASA did not have the technology the clients needed.

It is, we believe at this point, safe to say that successful networking depends significantly on a user-orientation in the transfer system. In a network seeking to respond to a user need, everyone involved in the search and referral network can be counted as a contributor to the final solution. Conversely, a technology resource orientation will attempt, by definition of its function, to search out users for its limited resources, and can legitimately bypass potential clients with other needs. At best, it will refer such clients away, or (as has been the case with the Agricultural Extension Service) make those needs the topics of longer term research and thus defer the solution by several years until it can provide the solution. This has been and is acceptable when, and if, in fact there were and are no possible solutions elsewhere.

It was a user orientation which led NASA and the Navy to develop secondary writeups -- "Tech Briefs" -- to describe their developments from a perspective sometimes quite different than that of the original innovators and documenters of the technology. A user orientation led to PTI's local government technology needs studies and to CSG's current new programs. A user orientation led to the 1985 trial linkages of NASA's IACs with the FLC's member laboratories, and to current efforts to give continuity to that linkage. All of the state-sponsored efforts have been user-oriented in original intent, if not in execution. In industry, Lockheed has made a profitable business out of aggregating or "networking" user access to technical data bases through Dialog.

As increasing numbers of participants (i.e., producers and intermediaries) in technology transfer become user-oriented, those who are not will come to be bypassed by clients in search of answers. For this is a world, as the Assistant Secretary of Commerce for Productivity, Technology, and Innovation so forcefully points out in his speeches, in which the vast majority of relevant advanced knowledge for technological problem solving is less than 15 years old, and in which over half of the scientists and engineers who ever lived are alive and productive. The relevance of knowledge across disciplinary lines is increasing. Spinoffs from one field to another are commonplace. The serendipitous is not only expected, but allowed for in advance planning. In such a climate, we believe it is far more efficient and effective to properly describe an innovation or innovator, put that description into an access system and let the user find it. It is difficult, if not costly, to get others to move your technology for you. It is easy and relatively inexpensive to draw on the interest and motivation of others in drawing on your technology to solve their, or their clients', problems.

Accordingly, the most effective strategy for transferring any body of technology is, we believe, a strategy of indirection. Make the technology accessible, within appropriate limits (security, economic, etc.), along with other advanced technology, and concentrate on helping appropriate users discover it in the context of finding the best solutions to their problems or needs out of the technological alternatives available, regardless of their source.

Now, an effective strategy is necessarily realistic as to the present, and objective as to the future. The present day institutional setting for technology transfer activities is dynamic, diverse, proliferating, and quantitatively and qualitatively uneven. Centralization (or even total coordination) is beyond considering, nor is it clear what useful service either might perform. Technology advances so swiftly, in so many dimensions, and its applications are so ubiquitous that the weaving of noncompulsory relationships seems to be the practical objective.

Thus, our strategy for building a nationwide network for technology transfer builds on the strengths and unique qualities of existing organizations, and proceeds to suggest relationships among them which will help all of them to draw on each other's strengths. Such a strategy requires that each participant be sensitive to the setting, goals, capabilities, and motivations of the other participants on which it may rely. And we repeat, for emphasis, only a user oriented mission can be counted on as an indicator of useful motivation in secondary transfer and in related problem definition and problem solving services.

2. Application of the Strategy, By Sector

a. Technology for Industry

It is in this area of technology, technical information and related technical services that the various state-supported efforts in about 35 of the states offer the most ready opportunities for networking. An additional 10 or so could be in this class (and many of the above 35 more effective) if and when they solve turf problems and develop an approach that is willing to look beyond their own state lines or their own universities' walls for answers to their industries' needs.

As we noted in Chapter I, the leading states are directing their effort in this area toward the generation of new economic activity. They want new jobs and an expanded tax base. Therefore, their efforts are directed toward entrepreneurs and toward small and medium-sized businesses, i.e., those sectors which have proven in recent years to be the sources of product and process innovation and job creation. Whether the states support or operate "technical assistance centers," "industrial extension services," "incubators," or whatever; their aims in this area are largely duplicative of the "value added services" of the NASA Industrial Applications Centers. From the user standpoint, the differences lie in the scope of information available; the professional quality of the problem-definition; search-assistance and problem-resolution services; proximity and convenience of access; cost (especially front-end, out-of-pocket); and the degree to which the related non-technical services (management and financing, especially) are available at, or conveniently close to, and accessible through direct referral from the technical assistance center.

On the other hand, lacking ties to such locally-focused groups, NASA's IACs have not been as successful in reaching these job-creating sectors of industry as they have been in reaching larger firms.

One reviewer (Andrew Wyckoff, Harvard) has questioned whether or not many of these state programs actually serve small business, or rather for reasons of convenience and efficiency end up serving intermediate-scale enterprise. Nonetheless, the states' purposes are clear, and the programs provide useful services to the industrial community. NASA has four significant contributions to offer these technical assistance activities: its name, its existing database search capabilities (including related analysis and interpretations), access to Field Center technical competence, and its experience (translatable into training and guidance). It also has the IACs' ability to function as neutral "buffers" between industrial clients, concerned for proprietary interests and (in some cases) anonymity, and the developers of the technology who either may not be sensitive to these concerns or may not be perceived by the clients as being sensitive. In return, it has the opportunity to gain more far-reaching access to industrial and commercial innovators, especially to those beyond the effective face-to-face service areas of the IACs and Field Centers, for fulfillment of the agency's "widest practicable dissemination" mandate.

We have singled out the IAC-state program relationship first because the IACs collectively are a unique, nationwide linking resource. Parallel to the IAC-state relationships in importance is the continuation and further development of the IAC-FLC referral system. This relationship strengthens the technology base available not only to IAC clients but, through the IACs, to clients of networked state programs. Pending completion of the evaluation of the trial year's experience, being performed by the participants in it, our preliminary review suggests the need to focus on the development of problem statement formats, standards and related protocols for referrals and responses. As guides to how to communicate around the system, these can underlie and support effective request-response exchanges where face-to-face communciations are impractical. They can be established by nothing more than consensus and informal agreement, or by a formal agreement between NASA and the FLC.

To stress an earlier point, however, each state has its own organization and its own expectations for the services it is providing or underwriting. Therefore, the approach to each state must be open-minded as to how the relationship should be packaged, and what it should include. Cooperation, in its most literal sense, is the result to be expected and desired.

A similar observation is needed with regard to each Federal agency having FLC member laboratories. A part of the success of NASA management over the first 25 years of the agency's life, and especially during the Apollo years, was due to its ability to bring about the successful accomplishment of complex technical projects involving hundreds of relatively autonomous participating organizations with minimal imposition of central management controls. Configuration management principles from that era can be applied to the sort of network we are describing -- even without a central controlling management. The demands on the collective leadership of the various participating groups are to provide a climate of expectations, direction, encouragement and stimulation -- in short, <u>to lead</u>.

At the same time that the FLC-IAC-state technical/business/innovation assistance efforts are being networked, the leaders of the various involved Federal agencies and programs might well consider ways of assuring that their various forms of assistance can be linked in the field. Representatives of NASA and the Small Business Administration have been holding discussions for several years, relative to the IAC-SBDC relationships. The leadership of EDA's University Centers program should be involved with them in similar interagency discussions.

The type of cooperation which we believe is possible in applying existing technology to industry needs also may be helpful in <u>adapting</u> technology to meet both private and public sector needs.

Over 15 years ago, NASA and the National Science Foundation helped pioneer the field of "technology needs analyses" with state and local governments. At that time, the emphasis was on the operational needs of those governments. The successors of those early efforts are now institutionalized through several national associations of public officials and through such non-profit public sector support groups as Public Technology, Inc.

In the recent wave of state interest in science and technology for economic development, attention has focused on the technology needs of industry to retain or regain its competitiveness. Several of the states have sponsored varying forms of survey analyses to guide the shaping of their state policies. To date, there has been little or no Federal involvement in these surveys, nor have Federal agencies effectively drawn on them. The NASA Technology Applications Teams and the related NASA technology applications projects potentially are in the position of serving as a nationwide focal point for the aggregation of such industry needs assessments consistent with proprietary interests, and/or for relating those which cannot be or are not being addressed through other resources to nationwide sources of technical support, such as those available through the network we have discussed above.

Effective linkage with the states in this area could also help NASA's applications engineering program to identify industry, university and state resources available for addressing widespread industry technology needs, and thus to potentially increase the leverage of NASA resources in the resolution of those needs. While this NASA effort, like IACs, is somewhat unique among Federal programs, it has drawn on -- and identified the existence of -- other Federal resources for its efforts. The strategy we propose is one of inviting wider cooperation and participation around a unique core resource.

b. <u>Technology for the Public Sector</u>

We mentioned that NASA and NSF pioneered, over 15 years ago, in public sector technology needs assessments, and in providing technical assistance to state and local officials and organizations. That continues to be an area in which the opportunity for further and/or revised linkages is possible. Public Technology, Inc. (PTI), which NASA helped start, has grown until it now serves as a major technical resource and technical needs clearinghouse for well over 150 of the largest local governments in this nation. Some state programs begun with National Science Foundation (NSF) support in the 1970s have been permanently established with state support. An example is the local government technology assistance effort at Oklahoma State University which is somewhat similar in mission and capability to the NASA/UK Technology Applications Program. Such assistance also is a part of the mission of the Pennsylvania Technology Assistance Program (PennTAP). The Council of State Governments (CSG), through an Institute for Science and Technology now being formed, is attempting to develop a central clearinghouse for many such state needs, and to link it with technical assistance services, drawing on the capabilities of the Federal laboratories. This is an effort with which NASA is seeking to develop a supporting relationship through the NASA/UK TAP, and one which warrants exploration of additional Federal linkages. The aggregation of multi-state needs for similar or the same new technologies has not been as successful in the past as has such aggregation of local government needs. The present effort of CSG is the first general initiative in this direction in some years.

c. Technology Transfer for Mission Enhancement

In the longer term -- looking to technologies for commercialization in five to 10 years -- the state-provided incentives for industry-university cooperation present an additional strategic opportunity for Federal officials. This is, quite possibly, an area for cooperation and networking in which the basic mission R&D interests and the technology transfer interests of Federal agencies blend together. If Federal technology transfer officials are to have a role in linking currently active programs with a variety of potential users of the technology being developed, to enhance both mission accomplishment and post-development applications, some effort should well be devoted to building links between appropriate state-funded industry/university centers of excellence and Federal technology development programs which have shared interests. These efforts should begin with systematic surveys and analyses of respective interests, leading to the identification of areas to be explored in detail. The information to support such surveys and analyses of state programs is readily available, the total number of such state-supported centers being presently in the neighborhood of 100, nationwide.

3. Conclusion

In conclusion, we would note that the vast excess of state over Federal financial resources for technology transfer is a reservoir that has been skimmed in places, but not widely tapped, by Federal technology transfer programs. In the words of the 1984 report to the President's Commission on Industrial Competitiveness, we believe that any Federal agency will do well to "work closely with states to design strategies that work for each state and the businesses in each state ... thus avoiding the need to identify general national solutions that may be inappropriate, given the diversity of the states and the different (sic) needs of industries." As the same report notes, "Many states have established applied technology centers that are assisting in the translation of R&D results into commercially useful products and processes by working closely with industries within the state."

Given the range and scope of these "centers," and the Federalism policies of the Administration (supported by 16 years of evolving bipartisan agreement) Federal agencies must seriously consider that report's strategic recommendation that, at the tactical level, "where the Federal government does act to promote industrial competitiveness, it should use state government whenever possible as the means for implementing its objective." The existing state technical assistance resources offer:

-- proximity to a far greater proportion of those segments of U.S. industry which can use new technology for new economic activity than has been or can be otherwise provided by direct Federal efforts;

-- not simply leveraging, but a <u>multiplier</u> effect in financial and human resources for direct industry contact, and for problem solving and other "engineering services;"

-- a wider, and therefore generally more stable, base of concern for Federal technology transfer program continuity than now exists; and

-- new, current, almost free sources of "intelligence" as to those technology needs of U.S. industry which may be candidates for the applications of Federally-developed technology.

To build such linkages will require discussion, education, mutual acquaintance and respect, the development of communication channels and protocols, and multilateral resource commitments. Such efforts, we believe, are well worth exploring in substantial depth.

We repeat, however, what has been stressed repeatedly. Each institution is unique. It is true for states and localities, it is true for industry, and it is true for the universities which states use as instrumentalities in assisting industry.

One current observer, Patricia Crosson, pointed at a recent national conference to the "diverse traditions, missions, purposes, constituencies, and external relationships" of these institutions, which "require different approaches and strategies" for their involvement in economic development. The need for such flexibility reinforces the value of networking as the tool for developing the wide-ranging nationwide capability which the conditions of the present-day and those expected for the future so clearly demand. It is slow and it sometimes appears to be uneven when viewed from a casual nationwide perspective, but it is likely to endure.

APPENDIX A

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